CCNA EXPLORATION V4.0
ROUTING PROTOCOLS AND CONCEPTS
INSTRUCTOR REFERENCE GUIDE

COMPARISON OF NEW CURRICULA WITH EXISTING CURRICULA

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Routing Protocols and Concepts Summary

New CCNA curriculum has been created to improve student experience, improve quality, and increase flexibility.

Routing Protocols and Concepts Course Outline

Following is the outline for this new course with indications as to which topics contain new content. Please note that P-New means that the original subject matter has been enhanced and/or there is additional subject matter in the section.

Course Outline				New / Existing Content
1.0			**Introduction to Routing and Packet Forwarding**	
	1.1		Inside the Router	
		1.1.1	Routers are Computers	P-New, 1.1.2
		1.1.2	Router CPU and Memory	P-New, 1.1.2, 1.2.2
		1.1.3	Internetwork Operating System	2.1.1
		1.1.4	Router Boot-up Process	2.2.1, 5.1.1, 5.1.2
		1.1.5	Router Interfaces	P-New, 1.2.3, 2.2.2
		1.1.6	Routers and the Network Layer	P-New, 1.1.3, 1.1.4
	1.2		CLI Configuration and Addressing	
		1.2.1	Implementing Basic Addressing Schemes	New
		1.2.2	Basic Router Configuration	3.1.1-3.1.7, 3.2.2-3.2.4
	1.3		Building the Routing Table	
		1.3.1	Introducing the Routing Table	P-New, 6.1.2, 9.1.1
		1.3.2	Directly-Connected Networks	P-New, 9.1.5
		1.3.3	Static Routing	P-New, 6.1.2
		1.3.4	Dynamic Routing	P-New, 6.1.2
		1.3.5	Routing Table Principles	New
	1.4		Path Determination and Switching Functions	
		1.4.1	Packet Fields and Frame Fields	P-New, 9.1.4
		1.4.2	Best Path and Metric	6.3.1-6.3.3
		1.4.3	Equal Cost Load Balancing	7.2.9
		1.4.4	Path Determination	P-New, 6.3.1
		1.4.5	Switching Function	P-New, 6.3.1
	1.5		Router Configuration Labs	
		1.5.1	Cabling a Network and Basic Router Configuration	1.2.5-1.2.7
		1.5.2	Basic Router Configuration	1.2.5-1.2.7, 2.2.4, 2.2.9
		1.5.3	Challenge Router Configuration	New
2.0			**Static Routing**	
	2.1		Routers and Network	
		2.1.1	Role of the Router	New
		2.1.2	Introducing the Topology	New

Course Outline				New / Existing Content
		2.1.3	Examining the Connections of the Router	P-New, 1.2.6, 1.2.7
	2.2		Router Configuration Review	
		2.2.1	Examining Router Interfaces	3.1.4, 3.1.5, 3.1.7
		2.2.2	Configuring an Ethernet Interface	P-New, 3.1.7
		2.2.3	Verifying Ethernet interface	P-New, 3.1.7
		2.2.4	Configuring a Serial Interface	P-New, 3.1.5
		2.2.5	Examining Router Interfaces	P-New, 3.1.5
	2.3		Exploring Directly Connected Networks	
		2.3.1	Verifying Changes to the Routing Table	3.1.5-3.1.7, 6.1.2, 9.1.1
		2.3.2	Devices on Directly Connected Networks	New
		2.3.3	Cisco Discovery Protocol (CDP)	P-New, 4.1.1
		2.3.4	Using CDP for Network Discovery	4.1.2-4.1.5
	2.4		Static Routes with "Next Hop" Addresses	
		2.4.1	Purpose and Command Syntax of ip route	6.1.2, 6.1.3
		2.4.2	Configuring Static Routes	P-New, 6.1.3
		2.4.3	Routing Table Principles and Static Routes	P-New, 6.1.5
		2.4.4	Resolving to an Exit Interface	New
	2.5		Static Routes with Exit Interfaces	
		2.5.1	Configuring a Static Route with an Exit interface	New
		2.5.2	Modifying Static Routes	New
		2.5.3	Verifying the Static Route Configuration	New
		2.5.4	Static Routes with Ethernet Interfaces	New
	2.6		Summary and Default Static Routes	
		2.6.1	Summary Static Routes	New
		2.6.2	Default Static Route	New
	2.7		Managing and Troubleshooting Static Routes	
		2.7.1	Static Routes and Packet Forwarding	New
		2.7.2	Troubleshooting a Missing Route	New
		2.7.3	Solving the Missing Route	New
	2.8		Static Route Configuration Labs	
		2.8.1	Basic Static Route Configuration	6.1.2, 6.1.3, 6.1.6
		2.8.2	Challenge Static Route Configuration	New
		2.8.3	Troubleshooting Static Routes	New
3.0			**Introduction to Dynamic Routing Protocols**	
	3.1		Introduction and Advantages	
		3.1.1	Perspective and Background	P-New, 6.2.1
		3.1.2	Network discovery and routing table maintenance	P-New, 6.2.1
		3.1.3	Advantages	New
	3.2		Classifying Dynamic Routing Protocols	
		3.2.1	Overview	6.2.4
		3.2.2	IGP and EGP	6.3.3

Course Outline				New / Existing Content
		3.2.3	Distance Vector and Link State	6.2.4-6.2.6
		3.2.4	Classful and Classless	New
		3.2.5	Convergence	6.2.3, 7.1.2
	3.3		Metrics	
		3.3.1	Purpose of a Metric	9.1.6
		3.3.2	Metrics and Routing Protocols	P-New, 9.1.6
		3.3.3	Load Balancing	7.2.9
	3.4		Administrative Distances	
		3.4.1	Purpose of Administrative Distance	9.1.5
		3.4.2	Dynamic Routing Protocols	P-New, 9.1.6
		3.4.3	Static Routes	P-New, 6.1.1, 6.1.2
		3.4.4	Directly Connected Networks	P-New, 9.1.5
	3.5		Routing Protocols and Subnetting Activities	
		3.5.1	Identifying Elements of the Routing Table	9.1.1, 9.1.5, 9.1.6
		3.5.2	Subnetting Scenario 1	New
		3.5.3	Subnetting Scenario 2	New
		3.5.4	Subnetting Scenario 3	New
4.0			**Distance Vector Routing Protocols**	
	4.1		Introduction to Distance Vector Routing Protocols	6.2.1, 6.2.3, 6.2.4
		4.1.1	Distance Vector Routing Protocols	6.2.4, 7.0
		4.1.2	Distance Vector Technology	6.2.5
		4.1.3	Routing Protocol Algorithms	6.2.5, 7.1.1
		4.1.4	Routing Protocol Characteristics	P-New, 6.3.3, 7.1.2
	4.2		Network Discovery	
		4.2.1	Cold Start	New
		4.2.2	Initial Exchange of Routing Information	7.2.2
		4.2.3	Exchange of Routing Information	7.2.2
		4.2.4	Convergence	P-New, 6.2.3, 7.1.2
	4.3		Routing Table Maintenance	
		4.3.1	Periodic Updates: RIPv1 and IGRP	P-New, 7.1.1, 7.1.3, 7.2.2
		4.3.2	Bounded Updates: EIGRP	New
		4.3.3	Triggered Updates	P-New, 7.1.6
		4.3.4	Random Jitter	New
	4.4		Routing Loops	
		4.4.1	Definition and Implications	P-New, 7.1.2
		4.4.2	Problem: Count to Infinity	7.1.3
		4.4.3	Setting a Maximum	7.1.3
		4.4.4	Preventing Routing Loops with Holddown Timers	7.1.7
		4.4.5	Split Horizon Rule	7.1.4
		4.4.6	Split Horizon with Poison Reverse or Route Poisoning	P-New, 7.1.5
		4.4.7	IP and TTL	New

Course Outline				New / Existing Content
	4.5		Distance Vector Routing Protocols today	
		4.5.1	RIP and EIGRP	P-New, 6.2.6, 7.2.1
	4.6		Lab Activities	
		4.6.1	Lab Activities	New
5.0			**RIP version 1**	
	5.1		RIPv1: Distance Vector, Classful Routing Protocol	
		5.1.1	Background and Perspective	P-New, 7.2.1
		5.1.2	RIPv1 Characteristics and Message Format	P-New, 6.2.5, 7.2.1
		5.1.3	RIP Operation	New
		5.1.4	Administrative Distance	9.1.5
	5.2		Basic RIPv1 Configuration	
		5.2.1	Basic RIPv1 Configuration	P-New, 7.2.2
		5.2.2	Enabling RIP: router rip command	7.2.2
		5.2.3	Specifying Networks	7.2.2
	5.3		Verification and Troubleshooting	
		5.3.1	Verifying RIP: show ip route	7.2.5, 7.2.6, 9.1.1
		5.3.2	Verifying RIP: show ip protocols	7.2.5, 7.2.6
		5.3.3	Verifying RIP: debug ip rip	7.2.6
		5.3.4	Passive Interfaces	7.2.7
	5.4		Automatic Summarization	
		5.4.1	Modified Topology: Scenario B	New
		5.4.2	Boundary Routers and Automatic Summarization	P-New, 7.2.3
		5.4.3	Processing RIP Updates	New
		5.4.4	Sending RIP Updates	P-New, 7.2.3, 7.2.6
		5.4.5	Advantages and Disadvantages of Automatic Summarization	P-New, 7.2.3, 7.2.6
	5.5		Default Route and RIPv1	
		5.5.1	Modified Topology: Scenario C	New
		5.5.2	Propagating the Default Route in RIPv1	New
	5.6		RIPv1 Configuration Labs	
		5.6.1	Basic RIP Configuration	P-New, 9.1.1, 9.1.2
		5.6.2	Challenge RIP Configuration	New
		5.6.3	RIP Troubleshooting	New
6.0			**VLSM and CIDR**	
	6.1		Classful and Classless Addressing	
		6.1.1	Classful IP Addressing	New
		6.1.2	Classful Routing Protocol	P-New, 7.2.2, 7.2.3
		6.1.3	Classless IP Addressing	New
		6.1.4	Classless Routing Protocol	P-New, 7.2.3
	6.2		VLSM	
		6.2.1	VLSM in Action	New
		6.2.2	VLSM and IP Addresses	New

Course Outline				New / Existing Content
	6.3		CIDR	
		6.3.1	Route Summarization	New
		6.3.2	Calculating Route Summarization	New
	6.4		VLSM and Route Summarization Activity	
		6.4.1	Basic VLSM Calculation and Addressing Design Activity	New
		6.4.2	Challenge VLSM Calculation and Addressing Design Activity	New
		6.4.3	Troubleshooting a VLSM Addressing Design Activity	New
		6.4.4	Basic Route Summarization Activity	New
		6.4.5	Challenge Route Summarization Activity	New
		6.4.6	Troubleshooting Route Summarization Activity	New
7.0			**RIPv2**	
	7.1		RIPv1 Limitations	
		7.1.1	Lab Topology	New
		7.1.2	RIPv1 Topology Limitations	New
		7.1.3	RIPv1: Discontiguous Networks	New
		7.1.4	RIPv1: No VLSM Support	New
		7.1.5	RIPv1: No CIDR Support	New
	7.2		Configuring RIPv2	
		7.2.1	Enabling and Verifying RIPv2	New
		7.2.2	Auto-summary and RIPv2	New
		7.2.3	Disabling Auto-Summary in RIPv2	New
		7.2.4	Verifying RIPv2 Updates	New
	7.3		VLSM and CIDR	
		7.3.1	RIPv2 and VLSM	New
		7.3.2	RIPv2 and CIDR	New
	7.4		Verifying and Troubleshooting RIPv2	
		7.4.1	Verification and Troubleshooting Commands	3.1.4, 4.2.5, 7.2.5, 9.2.2, 7.2.6
		7.4.2	Common RIPv2 Issues	New
		7.4.3	Authentication	New
	7.5		RIPv2 Configuration Labs	
		7.5.1	Basic RIPv2 Configuration	New
		7.5.2	Challenge RIPv2 Configuration	New
		7.5.3	RIPv2 Troubleshooting	New
8.0			**The Routing Table: A Closer Look**	
	8.1		The Routing Table Structure	
		8.1.1	Lab Topology	New
		8.1.2	Routing Table Entries	New
		8.1.3	Level 1 Routes	New
		8.1.4	Parent and Child Routes: Classful Networks	New

Course Outline				New / Existing Content
		8.1.5	Parent and Child Routes: Classless Networks	New
	8.2		Routing Table Lookup Process	
		8.2.1	Steps in the Route Lookup Process	New
		8.2.2	Longest Match: Level 1 Network Routes	New
		8.2.3	Longest Match: Level 1 Parent and Level 2 Child Routes	New
	8.3		Routing Behavior	
		8.3.1	Classful and Classless Routing Behavior	New
		8.3.2	Classful Routing Behavior: no ip classless	P-New, 7.2.3
		8.3.3	Classful Routing Behavior – Search Process	New
		8.3.4	Classless Routing Behavior: ip classless	New
		8.3.5	Classless Routing Behavior – Search Process	New
	8.4		Routing Table Labs	
		8.4.1	Investigating the Routing Table Lookup Process	New
		8.4.2	The show ip route Challenge Lab	New
9.0			**EIGRP**	
	9.1		Introduction to EIGRP	P-New, 6.2.1, 6.2.6, 6.3.3
		9.1.1	EIGRP: An Enhanced Distance Vector Routing Protocol	P-New, 7.3.1, 7.3.2
		9.1.2	EIGRP Message Format	New
		9.1.3	Protocol Dependent Modules (PDM)	New
		9.1.4	RTP and EIGRP Packet Types	New
		9.1.5	Hello Protocol	New
		9.1.6	EIGRP Bounded Updates	New
		9.1.7	DUAL: An Introduction	New
		9.1.8	Administrative Distance	P-New, 9.1.5
		9.1.9	Authentication	New
	9.2		Basic EIGRP Configuration	
		9.2.1	EIGRP Network Topology	New
		9.2.2	Autonomous Systems and Process IDs	P-New, 6.2.2, 6.2.3
		9.2.3	The router eigrp command	P-New, 6.3.2
		9.2.4	The network Command	P-New, 6.3.2
		9.2.5	Verifying EIGRP	New
		9.2.6	Examining the Routing Table	New
	9.3		EIGRP Metric Calculation	
		9.3.1	EIGRP Composite Metric and the K Values	New
		9.3.2	EIGRP Metrics	New
		9.3.3	Using the bandwidth Command	New
		9.3.4	Calculating the EIGRP Metric	New
	9.4		DUAL	
		9.4.1	DUAL Concepts	New

Course Outline				New / Existing Content
		9.4.2	Successor and Feasible Distance	New
		9.4.3	Feasible Successor, Feasibility Condition and Reported Distance	New
		9.4.4	Topology Table: Successor and Feasible Successor	New
		9.4.5	Topology Table: No Feasible Successor	New
		9.4.6	Finite State Machine	New
	9.5		More EIGRP Configuration	
		9.5.1	The Null0 Summary Route	New
		9.5.2	Disabling Automatic Summarization	New
		9.5.3	Manual Summarization	New
		9.5.4	EIGRP Default Route	New
		9.5.5	Fine-tuning EIGRP	New
	9.6		EIGRP Configuration Labs	
		9.6.1	Basic EIGRP Configuration Lab	New
		9.6.2	Challenge EIGRP Configuration Lab	New
		9.6.3	Troubleshooting EIGRP Configuration Lab	New
10.0			**Link-State Routing Protocols**	
	10.1		Link-State Routing	
		10.1.1	Link-State Routing Protocols	P-New, 6.2.6, 6.3.5
		10.1.2	Introduction to the SPF Algorithm	P-New, 6.2.6, 6.3.5
		10.1.3	Link-State Routing Process	P-New, 6.2.6, 6.3.5
		10.1.4	Learning about Directly Connected Routes	New
		10.1.5	Sending Hello Packets to Neighbors	New
		10.1.6	Building the Link-State Packet	New
		10.1.7	Flooding Link-State Packets to Neighbors	New
		10.1.8	Constructing a Link-State Database	New
		10.1.9	Shortest Path First (SPF) Tree	
	10.2		Implementing Link-State Routing Protocols	
		10.2.1	Advantages of a Link-State Routing Protocol	New
		10.2.2	Requirements of a Link-State Routing Protocol	New
		10.2.3	Comparison of Link-State Routing Protocols	New
11.0			**OSPF**	
	11.1		Introduction to OSPF	
		11.1.1	Background of OSPF	New
		11.1.2	OSPF Message Encapsulation	New
		11.1.3	OSPF Packet Types	New
		11.1.4	Hello Protocol	New
		11.1.5	OSPF Link-state Updates	New
		11.1.6	OSPF Algorithm	New
		11.1.7	Administrative Distance	New
		11.1.8	Authentication	New
	11.2		Basic OSPF Configuration	

Course Outline				New / Existing Content
		11.2.1	Lab Topology	New
		11.2.2	The router ospf Command	New
		11.2.3	The network Command	New
		11.2.4	OSPF Router ID	New
		11.2.5	Verifying OSPF	New
		11.2.6	Examining the Routing Table	New
	11.3		The OSPF Metric	
		11.3.1	OSPF Metric	New
		11.3.2	Modifying the Cost of the Link	New
	11.4		OSPF and Multiaccess Networks	
		11.4.1	Challenges in Multiaccess Networks	New
		11.4.2	DR/BDR Election Process	New
		11.4.3	OSPF Interface Priority	New
	11.5		More OSPF Configuration	
		11.5.1	Redistributing an OSPF Default Route	New
		11.5.2	Fine-tuning OSPF	New
	11.6		OSPF Configuration Labs	
		11.6.1	Basic OSPF Configuration Lab	New
		11.6.2	Challenge OSPF Configuration Lab	New
		11.6.3	Troubleshooting OSPF Configuration Lab	New

Routing Protocols and Concepts Summary of Skills and Equipments Changes

There are new skills as well as new equipment being introduced in the CCNA Exploration curriculum.

NEW SKILLS REQUIRED
Following is a list of the new skills that shall be required for the Routing Protocols and Concepts course:

- Advanced examination of routing tables
- OSPF troubleshooting
- EIGRP troubleshooting
- Advance use of Packet Tracer 4.1 or greater

EQUIPMENT REQUIRED
Academies adopting all CCNA Discovery courses and/or all CCNA Exploration courses - Minimum Required Equipment Bundle:
In order to be able to implement the different topologies that are used in the lab exercises of the CCNA curricula, Academies teaching the four courses of either CCNA Exploration and/or CCNA Discovery require as a minimum the following equipment:

- 3 Cisco 1841 Integrated Services Routers (ISR) with Base IP IOS 12.4
- 3 2960 switches
- 2 Linksys wireless routers (Linksys 300N is preferred but 54G is alternative) or SOHO equivalent (Linksys WRV200)

Note: The routers and switches in this equipment bundles can be substituted by other models of Cisco routers and switches with equal or higher specifications.

Additional Lab Equipment Required:
In addition to the networking equipment specified above, the lab topologies of CCNA Exploration and Discovery require the use of the following equipment and accessories:

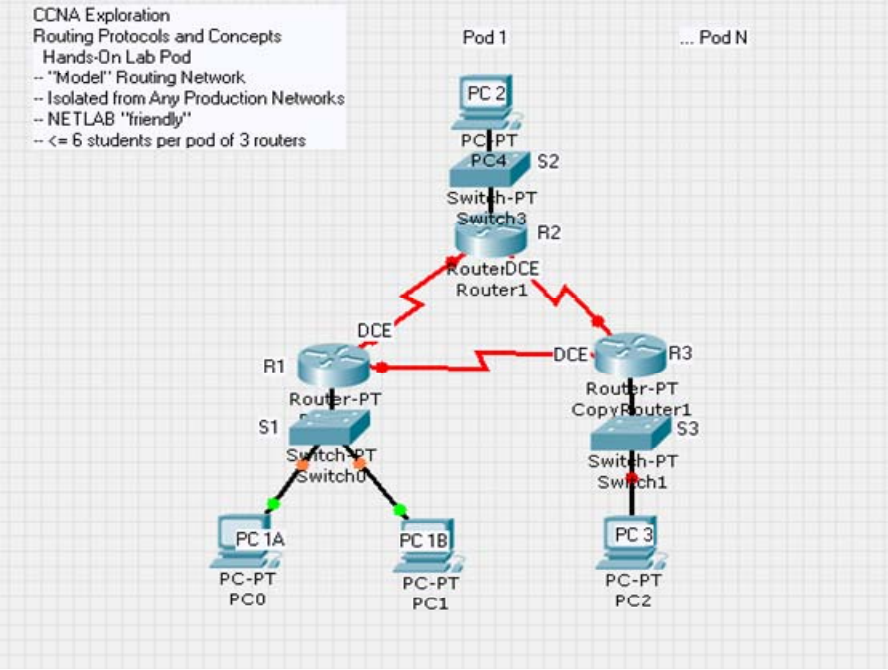
- 1 PC acting as an Application Server
- 2 desktop/laptop PCs acting as clients
- NIC Cards for the PC server and PC clients
- 2 Wireless LAN Adapters for the client PCs
- Ethernet cables and Serial Cables
- Cable-making and testing equipment

IOS Option:
In order to keep equipment investment to a minimum, the Product Development team designed all lab exercises for both CCNA Exploration and Discovery using the BASE IP IOS 12.4. For those Academies that wish to drill deeper into some of the routing functionalities, Cisco recommends an upgrade of the BASE IP IOS to the Advanced Services IOS. In addition to the software itself, this upgrade requires additional DRAM and Flash memories for the 1841 Routers. Details of the upgrade can be found in the Advanced IP Options tab of this document.

Mounting Rack Accessories:
The 1841 is a desktop router. Academies that prefer to install lab equipment in standard 19" racks can use the optional Rack Kit for the 1841.

Topologies:

CCNA Exploration 2 – Routing Protocols and Concepts Lab Topology



Summary of Changes

- Integrated use of Packet Tracer for network visualization, skill building and simulation.
- Removal of content related to IGRP, TCP, and ICMP. TCP and ICMP are covered in Network Fundamentals.
- IGRP is no longer supported by Cisco.
- More challenging lab activities including skill building and troubleshooting practice.
- Content covering Access-Control Lists has been moved to the fourth Exploration course for managing traffic and security.
- Core topic for the course is a higher level of routing and routing protocols brought down from CCNA 3 and 4 courses such as OSPF, and EIGRP, VLSM and CIDR.